

Introduction

How can the Army science and technology (S&T) community help achieve the revolutionary capabilities envisioned for the soldier of the Objective Force? What if it were possible to develop compact soldier-system power sources with increased energy and power densities using technology based on nanostructured electrodes or novel fuel preprocessors? What if enhanced displays, antennas, and sensors providing improved communications and enhanced security could be designed through the use of nanoscale devices? What if novel materials could be engineered to allow the integration of sensors and electronics that allow active camouflage and self-repairing equipment? To address these questions and other potential applications of nanotechnology, the Army Research Office (ARO) sponsored a workshop in February 2001. Workshop participants concluded that nanotechnology has the potential to dramatically impact all aspects of soldier equipment and apparel, not only those areas mentioned above. In addition, it was resolved that the establishment of a center for nanotechnology focused on soldier systems would provide synergistic benefits to accelerate nanotechnology research and development.

To realize the promise that nanotechnology holds for improving the survivability of the soldier, the Assistant Secretary of the Army for Acquisition, Logistics and Technology asked ARO to create a University Affiliated Research Center (UARC) entitled the Institute for Soldier Nanotechnologies (ISN). The ISN will be the first DOD research facility committed to both basic and applied research in nanoscience and nanotechnology, with a focus on transition opportunities for soldier technology. The emphasis on the development of soldier system technology will also facilitate the integration of the warfighter with the Future Combat Systems (FCS) and the Objective Force.

INSTITUTE FOR SOLDIER NANOTECHNOLOGIES

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Background

On Dec. 29, 1959, Nobel Prize-winning physicist Richard Feynman spoke at the annual meeting of the American Physical Society. The title of his address was "There's Plenty of Room at the Bottom." His premise was that the principles of physics do not speak against the possibility of maneuvering things atom by atom. Feynman further discussed the challenges and implications of manipulating and controlling things at the atomic scale. His speech laid the intellectual foundation for what is known as nanoscience or nanotechnology (where nano refers to nanometers or 10^{-9} meters). Specifically, nanotechnology refers to the ability to engineer devices or structures that have at least one dimension of 100 nanometers (0.1 μ m) or less, and assemble these into useful macroscopic systems. (For purposes of reference, a human hair is approximately 50,000 nanometers in width.) The advantages this offers are that different functionalities can be built into a material, and combinations of properties can be achieved that have never before been possible.

Recent advances in the field suggest that nanotechnology can provide a wide array of new materials and systems with enhanced capabilities. One example is nanoclay-filled polymers, which have demonstrated unique hardness, strength, and chemical impermeability that makes

them potentially useful for visor and windscreen applications. The Army is currently investigating these materials for transparent armor, while the Air Force is looking into possible canopy applications. Another example is the photonic band-gap materials, which can effectively block light of a single wavelength while being otherwise transparent. These materials have obvious potential as protection from laser dazzling or laser blinding. A third example is the blending of nanomaterials with biotechnology, which has produced a number of interesting applications in biological and chemical agent detection. Advances such as these indicate that it may be possible to provide the soldier with radical new capabilities without incurring significant weight or volume penalties.

Objective

The purpose of this research center of excellence is to develop unclassified nanometer-scale S&T solutions for the soldier. A single university will host this center, which will emphasize revolutionary materials research focused on advancing soldier protection and survivability. The ISN will serve as the Army's focal point for basic research into nanotechnology for application to the future soldier. Further, the ISN will be expected to serve as an Army corps of technical expertise, providing nanotechnology-related basic research and technical support to Army intramural and

extramural applied research and development projects for advanced and enabling technologies required by both the soldier and soldier support systems. The ISN will perform cooperative research with industry; the Army Research Laboratory; the Army's Natick Soldier Center; and other Army research, development and engineering centers to transition new technologies from the laboratory to new products for the soldier and to spin-off commercial applications.

The research will emphasize integration of a wide range of functions, including multithreat protection against ballistics, sensory attack, and chemical and biological agents; climate control through possible development of chameleon-like garments that insulate and respond to cold and hot temperatures; biomedical monitoring; and load management. The objective is to enable a revolutionary advance in soldier survivability through the development of novel materials for integration into the Objective Force Warrior system. To be effective, the research solutions must be compatible with a variety of complicating factors, including soldier mission requirements, limited energy resources, communication needs, and requirements for ruggedization to perform in extremes of temperature, humidity, storage, damage, and soilage.

A major goal of the ISN is to create an expansive array of nanotechnology-based innovations in a variety of survivability-related areas that will be harvested by the industrial partners for future Army application. To facilitate this, the ISN will aggressively garner industrial participation. The interrelationship between university innovation and industrial integration will be constantly evolving, driven by opportunities arising from cutting-edge research and responding to changing Army requirements. The ISN's management must provide a flexible means for managing the industrial participation and adapting to change

while maintaining focus on the core goals of the ISN. A criterion for selection will be a comprehensive and compelling plan for creating innovation and managing technology transition from the laboratory to practical innovative applications.

Solicitation And Schedule

The university host will be selected through a limited competition with the intention of creating a unique national asset for conducting revolutionary materials research. The Army will invest more than \$10 million annually in the ISN. The university host will provide a dedicated facility for this UARC and, along with its industrial partners, will commit significant infrastructure, resources, and personnel to complement the government's investment. The university will create cooperative partnerships with industry that will ensure that the technical innovations emerging from the research will transition rapidly into militarily relevant applications and result in producible technologies. Partnerships with industry are expected to be a key factor in the success of the ISN. Industry partners are expected to place personnel at the ISN, to bear the cost of their onsite personnel, and to co-invest in the development and/or operation of the ISN.

The initial announcement and a draft of the Broad Agency Announcement (BAA) were published in the second half of 2001. In addition, several advertisements have been placed in technical journals and trade magazines. Several news articles have also appeared during this time period, bringing more attention to the pending solicitation. A Web site (<http://www.aro.army.mil/soldiernano/index.html>) was set up to serve as a single source for current information about the solicitation and to post answers to frequently asked questions about the ISN and the Army's intentions.

In mid-August 2001, a series of meetings were held to announce the Army's intention to establish the ISN,

to answer questions about the draft solicitation, and to hear concerns from potential bidders on the scope and requirements. A number of universities have expressed interest in hosting the institute, and the Army expects to receive between 30 and 40 proposals for consideration.

The final version of the ISN BAA was approved and officially posted Oct. 15, 2001, with a proposal deadline of Jan. 3, 2002. Evaluation of proposals began in early January and will result in a source-selection authority decision in March 2002. Once the Director of Defense Research and Engineering approves the UARC core competencies statement, a contract will be awarded. This is expected to occur in June 2002.

Conclusion

Modern warfare is placing new demands on the soldier for rapid response and flexibility. The Army recognizes this new reality and is evolving to meet it. The immediate goals are manifested in the FCS and the Objective Force Warrior Program. Future research programs that seek to integrate functionality to enhance the soldier's survivability, mobility, flexibility, and lethality will complement these goals. The Army's Institute for Soldier Nanotechnologies will work to develop new technologies that improve this integration and help soldiers of the future better operate in their battlespace.

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